MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

EEL 3086 – SWITCHGEAR AND PROTECTION

10 JULY 2023
9:00 AM – 11:00 AM
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages including cover page with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) Explain why a circuit breaker must act as fast as possible when a fault is detected. Support your answer with an appropriate example. [4 marks]

(b) Give FOUR main criteria which can be used for fault detection. Briefly explain how each of the criteria works. [8 marks]

(c) The first level of protection is provided by the primary protection system, which is usually a combination of circuit breakers and protective relays. The primary protection system is designed to operate quickly and clear the fault before any damage can occur.

(i) Identify THREE examples of primary protection system failures. [3 marks]

(ii) In the event of primary protection system failure, backup protection should take over. Discuss the concept of backup protection. Use an appropriate diagram to illustrate your discussion. [7 marks]

(d) Express THREE advantages of a numerical relay over an electromechanical relay. [3 marks]

Continued...

Question 2

(a) A 500:1 current transformer with a core area of 7 in^2 has a maximum flux of 1.5 T. The operating frequency of this current transformer is 50 Hz. Suppose that 1 inch is 0.0254 m. Assess whether this current transformer can be used when the secondary voltage is 800 V. [5 marks]

(b) Figure Q2b(i) shows a typical power system with a protection system in place. CO-7 relays are used for R_1 and R_2. Given that the time grading margin between the relays is 0.6 s and the time multiplier setting (TMS) of relay R_1 is 3 s. By referring to the characteristic curve of the relays as shown in Figure Q2b(ii), determine:

i) the operation time for R_1 when a fault of 3000 A occurs at Bus C. [6 marks]

ii) the time setting multiplier of R_2. [7 marks]

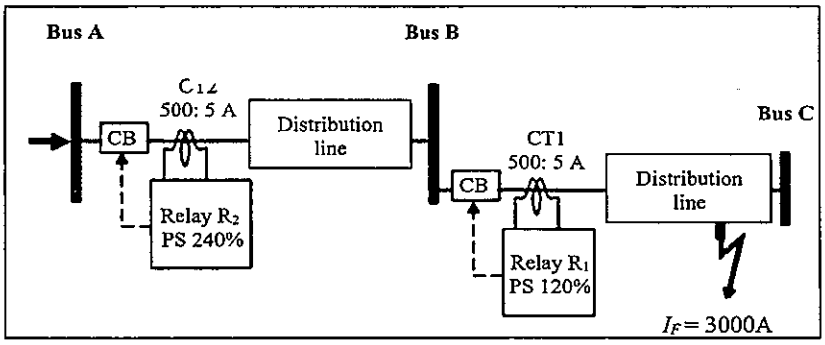

Figure Q2b(i)

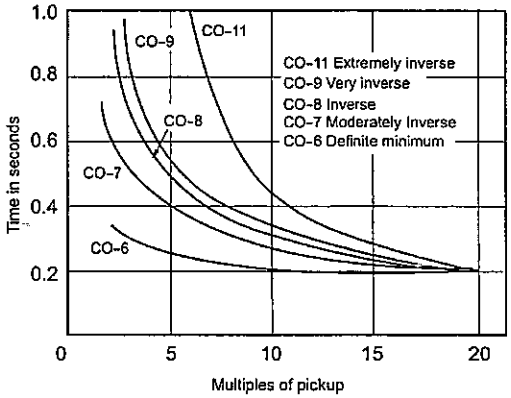

Figure Q2b(ii)

(c) Assess the importance of instrument transformers in power system protection. Provide TWO reasons. [4 marks]

(d) Produce THREE factors which may impact the accuracy of a current transformer. [3 marks]

Continued...

Question 3

(a) Distinguish between SF_6 and Oil circuit breaker by explaining THREE differences between the aforementioned type of circuit breaker. [9 marks]

(b) Identify the THREE main stages of arc formation. [3 marks]

(c) Over a period of one year, an overcurrent relay had operated 50 times, out of which 38 were correct trips. If the relay failed to issue the trip decision on 11 occasions, evaluate the performance of the relay in terms of the percentage of dependability, security, and reliability. Then, recommend THREE methods to improve the performance of the relay. [13 marks]

Question 4

(a) Appraise the importance of generator protection. [4 marks]

(b) The stator winding of a generator is protected by a percentage differential protection relay as shown in Figure Q4(b). i_1 and i_2 are given as (500 +j0) A and (450 +j0) A respectively. The relay has 0.25A minimum pick up current and a 18% slope of characteristic. A high resistance ground fault happens near the grounded neutral end of the generator winding while generator is carrying load. Assuming that the CTs are rated at 600/5 A. Analyse whether the relay will trip the circuit breaker under this fault condition. [14 marks]

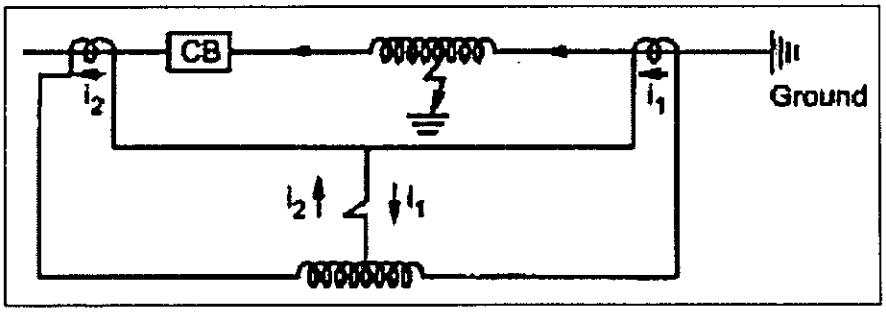

Figure Q4(b)

(c) Once power is generated by the generator, busbars serves as an important link between incoming and outgoing circuits. With an appropriate diagram, illustrate how differential protection can be used for busbar protection. [7 marks]

End of Paper